



**UNIVERSITI PUTRA MALAYSIA**

**MODELLING AND DEVELOPMENT OF AN IMPROVED SORTING  
SYSTEM IN THE PLYWOOD GRADING LINE**

**MOHAMAD SATTAR BIN RASUL**

**FK 2003 63**

**MODELLING AND DEVELOPMENT OF AN IMPROVED SORTING  
SYSTEM IN THE PLYWOOD GRADING LINE**

**By**

**MOHAMAD SATTAR BIN RASUL**

**Thesis Submitted to the School of Graduates Studies, Universiti Putra Malaysia,  
in Fulfilment of the Requirements for the Degree of Master of Science**

**November 2003**



## **DEDICATION**

To my loving wife, Rose Amnah and my kids, Effa, Rizal, Shidee, Rina and Syahin for their support and encouragement, I am deeply grateful. I dedicate in loving memories to my late parents Rasul bin Lokman and Rokiah binti Iskandar, may god bless them.

Abstract of thesis presented to the Senate of University Putra Malaysia in fulfilment  
of the requirement for the degree of Master of Science

**MODELLING AND DEVELOPMENT OF AN IMPROVED SORTING  
SYSTEM IN THE PLYWOOD GRADING LINE**

By

**MOHAMAD SATTAR BIN RASUL**

**November 2003**

**Chairman: Associate Professor Napsiah Ismail, Ph.D.**

**Faculty: Engineering**

The main focus of this study is on the sorting method of graded plywood in the grading line. The plywood grading line is the final process in the production line. Due to the inefficiency of the sorting method, this line has low productivity, high labor usage and defectives due to improper sorting of the plywood by the operator. The collected statistics were analyzed and the output analysis deals with drawing the comparison between the existing grading line and the built model. This study has eight aspects measured in order to achieve the objectives. They are; time study, production rate, labor cost, labor productivity, capacity utilization, defective rate, investment cost and downtime. Overall comparison for sorting graded plywood between existing system and proposed systems (pneumatic and hydraulic systems), shows that, the sorting time was reduced to 20.3% using pneumatic sorting system whereas 10.9 % using hydraulic sorting system. Hence increasing the production rate by 38.9% and 32.5% accordingly.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan ijazah Master Sains

**MEREKABENTUK MODEL DAN PEMBANGUNAN PENAMBAH BAIKAN  
SISTEM PENGAGIHAN DI DALAM BARIS PENGREDAN PAPAN LAPIS**

**Oleh**

**MOHAMAD SATTAR BIN RASUL**

**November 2003**

**Pengerusi:   Profesor Madya Napsiah Ismail, Ph.D.**

**Fakulti:       Kejuruteraan**

Fokus utama kajian ini ialah pada kaedah pengagihan papan lapis yang telah digredkan. Proses pengredan ini merupakan proses yang terakhir di dalam proses pengeluaran papan lapis. Teknik pengagihan yang tidak cekap pada sistem sedia ada, menyebabkan kadar pengeluaran yang rendah, kadar penggunaan buruh yang tinggi dan peningkatan kerosakan papan lapis akibat dari kesan tolakan yang tidak seragam dari operator. Kajian ini meliputi lapan aspek yang diuji iaitu kajian masa, kadar pengeluaran, kos buruh, produktiviti buruh, kapasiti penggunaan, kadar kerosakan, kos pelaburan dan lengah masa. Perbandingan secara keseluruhan antara sistem sedia ada dengan sistem cadangan (pneumatik dan haidraulik) menunjukkan melalui sistem cadangan banyak aspek telah ditingkatkan. Melalui sistem pneumatik didapati 20.3% masa pengagihan dapat dikurangkan, manakala 10.9% masa dapat dikurangkan melalui sistem haidraulik. Sekaligus ini meningkatkan kadar pengeluaran sebanyak 38.9% melalui sistem pneumatik dan 32.5% melalui sistem haidraulik.

## **ACKNOWLEDGEMENTS**

This report was produced in co-operation with Mentiga Corporation Berhad in Pekan, Pahang and is based on a review of relevant literature and consultations with executives of focus groups and specialists. Their able and dedicated contributions, as well as the guidance provided by lecturers from University Putra Malaysia, Dr. Napsiah Ismail, Ir. Dr. Md. Yusof Ismail and Dr. Megat Mohamad Hamdan are gratefully acknowledged. I would also thank the mechanical engineering department of Politeknik Sultan Haji Ahmad Shah, Kuantan, Pahang for the equipment used.

I certify that an Examination Committee met on 22<sup>nd</sup> November 2003 to conduct the final examination of Mohamad Sattar bin Rasul on his Master of Science thesis entitled "Modelling and Development of an Improved Sorting System in the Plywood Grading Line" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

**IR. YAAKOB SALLEH**

Faculty of Engineering  
Universiti Putra Malaysia  
(Chairman)

**NAPSIAH ISMAIL, Ph.D.**

Associate Professor  
Faculty of Engineering  
Universiti Putra Malaysia  
(Member)

**MD. YUSOF ISMAIL, Ph.D.**

Associate Professor  
Fakulti Sains Pertanian dan Makanan  
Universiti Putra Malaysia Kampus Bintulu  
Jalan Nyabau  
97008 Bintulu  
Sarawak  
(Member)

**MEGAT MOHAMAD HAMDAN MEGAT AHMAD, Ph.D.**

Associate Professor  
Faculty of Engineering  
Universiti Putra Malaysia  
(Member)

---

**GULAM RUSUL RAHMAT ALI, Ph.D.**  
Professor/Deputy Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date: 05 MAR 2004

This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of Supervisory Committee are as follows:

**NAPSIAH ISMAIL, Ph.D.**

Associate Professor  
Faculty of Graduate Studies  
Universiti Putra Malaysia  
(Chairman)

**MD. YUSOF ISMAIL, Ph.D.**

Associate Professor  
Faculty of Graduate Studies  
Universiti Putra Malaysia  
(Member)

**MEGAT MOHAMAD HAMDAN, Ph.D.**

Associate Professor  
Faculty of Graduate Studies  
Universiti Putra Malaysia  
(Member)



---

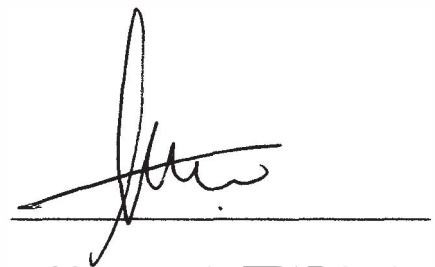
**AINI IDERIS, Ph. D.**  
Professor/Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date: 22 MAR 2004



## **DECLARATION**

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledge. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institution.

A handwritten signature in black ink, consisting of a large loop followed by several smaller, connected strokes, is written over a horizontal line.

**MOHAMAD SATTAR RASUL**

Date: 25 December 2003

## TABLE OF CONTENTS

	<b>Page</b>
DEDICATION	ii
ABSTRACT	iii
ABSTRAK	iv
ACKNOWLEDGEMENTS	v
APPROVAL	vi
DECLARATION	viii
LIST OF TABLES	xii
LIST OF FIGURES	xiv
GLOSSARY OF TERMS	xvii
 <b>CHAPTER</b>	
<b>1 INTRODUCTION</b>	
1.1 Introduction	1
1.2 Background Problem	3
1.3 Problem Statement	5
1.4 Objectives	7
1.5 Scope of The Study	7
 <b>2 LITERATURE REVIEW</b>	
2.1 Introduction	8
2.2 The Automation System Adoption in Malaysia Manufacturing Industries	8
2.3 Evaluation of an Automated Plywood Grading System	10
2.4 Factors to be Considered in The Design of a Grading System	12
2.5 Sorting System in the Plywood Grading Line	14
2.6 The Kinematic Layout	15
2.7 Fluid Power System	17
2.8 Linear Motion Control	18
2.8.1 Characteristic and Application of Pneumatics	19
2.8.2 Pneumatic Cylinder Calculation	21
2.8.3 Advantages and Distinguishing Characteristics of Compressed Air (Pneumatics)	22
2.8.4 Electro-Pneumatic Converter System	23
2.9 Control Technology	24
2.9.1 Programmable Logic Control-Systems (PLC)	24
2.9.2 The Components of a PLC	25
2.10 Material Handling System	27
2.11 Work -Study	28
2.11.1 Techniques of Work-Study	29
2.11.2 Method Study	31
2.12 Work Measurement	33
2.12.1 Time Study	35

	2.12.2 Standard Time	37
2.13	Computer Simulation and Benefits of Simulation in Manufacturing Industry	40
3	METHODOLOGY	
3.1	Introduction	42
3.2	Research Design	42
3.3	Define The Problem	43
3.4	Data Collection on Existing Sorting System	44
3.5	Work Study and Analysis Method on Existing Sorting System	45
	3.5.1 Time Study Measurement	46
	3.5.2 Production Rate Measurement	50
	3.5.3 Labor Cost and Labor Productivity Measurement	51
	3.5.4 Capacity Utilization Measurement	51
	3.5.5 Defective Rate Measurement	52
	3.5.6 Machine Breakdown Analysis	52
3.6	Model Development	53
3.7	Model Verification and Validation	55
3.8	Work Study and Analysis Method on Proposed Sorting System	55
3.9	Analyzing the Output	56
3.10	The Conceptual Framework	56
3.11	Pneumatic Simulation Professional (PneuSimPro)	58
4	RESULTS AND DISCUSSIONS	
4.1	Introduction	60
4.2	Existing Sorting System	60
	4.2.1 Time Study and Standard Time Measurement for Sorting and Distributing Graded Plywood on the Existing Sorting System	61
	4.2.2 Production Rate	66
	4.2.3 Labor Cost and Labor Productivity Measurement	67
	4.2.4 Capacity Utilization Measurement	68
	4.2.5 Defective Rate	69
	4.2.6 Machine Breakdown Analysis	71
4.3	Proposed Sorting System	71
	4.3.1 Model Development of Proposed Sorting Method	71
	4.3.2 Model 1 (Simulation)	72
	4.3.3 Programming of Sequence Control for Model 2 (Pneumatic System) and Model 3 (Hydraulic System)	74
	4.3.4 Calculation On cylinder Size and Force for Model 2 (Pneumatic System) and Model 3 (Hydraulic System)	77
	4.3.5 Design on Proposed Sorting Method for Model 2 (Pneumatic System)	79
	4.3.6 Time Study for Sorting and Distributing Graded Plywood for Model 2 (Pneumatic System)	81
	4.3.7 Production Rate for Proposed Model 2	86

	(Pneumatic System)	
4.3.8	Labor Cost and Labor Productivity Measurement for Proposed Model 2 (Pneumatic System) & Model 3 (Hydraulic System)	87
4.3.9	Capacity Utilization Measurement (Model 2)	88
4.3.10	Investment Cost for Model 2 (Pneumatic Sorting System)	90
4.3.11	Design on Proposed Sorting Method for Model 3 (Hydraulic System)	91
4.3.12	Time Study for Sorting and Distributing Graded Plywood for Model 3 (Hydraulic System)	92
4.3.13	Production Rate For Model 3 (Hydraulic Sorting System)	97
4.3.14	Capacity Utilization Measurement For Model 3 (Hydraulic Sorting System)	98
4.3.15	Investment Cost for Model 2 (Hydraulic Sorting System)	99
4.4	Analysis on the Existing and Proposed Plywood Grading Line	99
4.4.1	Comparison of the Sorting and Distributing Time for Graded Plywood Between Existing and Proposed System	100
4.4.2	Comparison of the Production Rate for Sorting Graded Plywood between Existing and Proposed System	101
4.4.3	Comparison of the Labor Cost and Labor Productivity for Sorting Graded Plywood between Existing and Proposed System	105
4.4.4	Comparison of the Capacity Utilization for Sorting Graded Plywood between the Existing and Proposed System	108
4.4.5	System Effectiveness Comparison for Sorting Graded Plywood between Existing and Proposed Systems	109
5	DISCUSSION & CONCLUSION	
5.1	Introduction	114
5.2	Conclusion	114
5.3	Recommendation and Future Research	118
	REFERENCES	122
	APPENDICES	127
	BIODATA OF THE AUTHOR	141

## LIST OF TABLES

Tables		Page
2.1	The advantages and the disadvantages of Mechanical System, Hydraulic System, Pneumatic System and Electrical System	16
2.2	A guide to the number of cycles to be observed	37
3.1	Data to be collected on the existing sorting system	45
3.2	Data to be collected and measured to examined the sorting methods effectiveness	46
3.3	Work sampling observation record for sorting graded Plywood	46
3.4	Graded plywood production rate measurement	50
3.5	Graded plywood distribution measurement	50
3.6	Average of labor cost on the grading line	51
3.7	Graded plywood defective rate measurement	52
4.1	Time study result on the existing sorting system	62
4.2	Graded plywood production rate on the existing grading line	67
4.3	Graded plywood distribution per day	67
4.4	Average of labor cost on the existing grading line	68
4.5	Weekly defective rate on the existing sorting system (March to May 2002)	70
4.6	Steps explanation for the control sequence of plywood sorting system for Model 1 (simulation system), Model 2 (Pneumatic system) and Model 3 (Hydraulic system)	77
4.7	Time study on proposed Model 2 (Pneumatic sorting system)	82
4.8	Graded plywood production rate on the proposed Model 2 sorting system	87

4.9	Labor cost for proposed Model 2 and Model 3	88
4.10	Equipment and installation cost for Model 2	90
4.11	Time study result on proposed Model 3(Hydraulic sorting system)	93
4.12	Graded plywood production rate on the proposed Model 3 sorting system	98
4.13	Equipment and installation cost for Model 3	99
4.14	Comparison of the standard time for sorting and distributing graded plywood between existing and proposed sorting system	100
4.15	Graded plywood production rate on the existing (March-May 2002) and proposed grading line	102
4.16	Average labor cost on the existing and proposed grading line	105
4.17	Peak utilization and effective utilization of the existing and proposed sorting system	108

## LIST OF FIGURES

Figure		Page
1.1	Grading line schematic diagram	6
2.1	Electrical, electronics, pneumatics and hydraulic signal flow	23
2.2	Signal flow for electrical-pneumatic or electrical-hydraulic system	24
2.3	The components of PLC	26
2.4	Programmable Logic Controller Schematic	27
2.5	Work-study flow chart	30
2.6	Standard Time Distribution	39
3.1	Research design flowchart for the development of the sorting system	43
3.2	Grading line process flow chart	47
3.3	Plywood grading line process chart	48
3.4	Sample for time study measurement for sorting graded plywood	49
3.5	Proposed models for plywood grading line	53
3.6	Simulation study approach	54
3.7	Conceptual framework for a study of the method of sorting in the plywood grading line	57
3.8	Pneumatic Simulation Professional (PneuSimPro) simulation software	59
4.1	Time study result for grade one plywood on the existing sorting system	63
4.2	Time study result for grade two plywood on the existing sorting system	64

4.3	Time study result for grade three plywood on the existing sorting system	65
4.4	Time study result for grade four plywood on the existing sorting system	66
4.5	Capacity utilization result on the existing sorting system	69
4.6	Simulation for Pneumatic and electrical circuit diagram for proposed pneumatic sorting system	73
4.7	Simulation for hydraulic and electrical circuit diagram for proposed hydraulic sorting system	73
4.8	Hard-wiring diagram for Model 2 (Pneumatic sorting system) And Model 3 (Hydraulic sorting system)	75
4.9	Function diagram for the sequence control of Model 2 (Pneumatic sorting system) and Model 3 (Hydraulic sorting system)	76
4.10	The force applied to the plywood	78
4.11	The front view of fabricated model for pneumatic proposed sorting system	80
4.12	The plan view of fabricated model for pneumatic proposed sorting system	81
4.13	Time study result for sorting and distributing grade one plywood on Model 2	83
4.14	Time study result for sorting and distributing grade two plywood on Model 2	84
4.15	Time study result for sorting and distributing grade three plywood on Model 2	85
4.16	Time study result for sorting and distributing grade four plywood on Model 2	86
4.17	Capacity utilization result on the proposed Model 2 sorting system	89



4.18	The front view of hydraulic proposed sorting system model	91
4.19	The side view of hydraulic proposed sorting system model	92
4.20	Time study result for sorting and distributing grade one plywood on Model 3	94
4.21	Time study result for sorting and distributing grade two plywood on Model 3	95
4.22	Time study result for sorting and distributing grade three plywood on Model 3	96
4.23	Time study result for sorting and distributing grade four plywood on Model 3	97
4.24	Capacity utilization result on the proposed sorting system Model 3	98
4.25	Comparison of the sorting time for graded plywood between existing and proposed sorting system	101
4.26	Graded plywood production rated on the existing and proposed sorting system	102
4.27	Labor cost on the existing and proposed sorting system	106
4.28	Labor productivity on the existing and proposed sorting system	107
4.29	Peak utilization and effective utilization of the existing and proposed sorting system	108
4.30	Overall comparison for sorting graded plywood between existing and proposed sorting system	111

## GLOSSARY

**Automation:** Automation is a system, process, or piece of equipment that is self-acting and self-regulating.

**Basic time:** Basic time is the time required to sort plywood to their respective station at standard rating.

**Capacity:** the maximum rate of output (production) for a process.

**Contingency allowance:** Contingency allowance is a small allowance of time, which may be included in a standard time to meet the legitimate and expected items of work or delay. It should not be greater than 5% of basic time.

**Defective rate:** Defective rate is a significant factor in manufacturing process. It determined the number of pieces plywood defected while in the process of sorting the goods. It is calculated per unit of time, such as hour, day, month, or year.

**Effective capacity:** Effective capacity is the maximum output (production) that a process or firm can economically sustain under normal conditions.

**Job flow time:** The amount of shop time for the job.

**Labor cost:** Labor cost is referred to the salary of the labor worked over a certain period such as hour, day, month, or year.

**Labor productivity:** Labor productivity is an index of the output (plywood sorted) per person or hours worked. In other words it is also the ratio of the value of output to labor hours.

**Makespan:** The total amount of time required to complete a group of jobs.

**Method study:** Method study is concerned with the reduction of work content of an operation, while work measurement is mostly concerned with the investigation and reduction of any time associated with it and with the subsequent establishment of time standards for the operation when carried out in the improved fashion.

**Peak capacity:** Peak capacity is the maximum output (production) that a process can achieve under ideal conditions.

**Process:** A process is any activity or group of activities that takes one or more inputs (grading, distributing, and sorting), transform and add value to them, and provide one or more outputs.

**Production rate:** Production rate is a significant factor in manufacturing process. It determined in the number of pieces plywood to be sorted per unit of time, such as hour, day, month, or year.

**Relaxation allowance:** Relaxation allowance is the allowance to provide the worker the opportunity to recover from the physiology and psychological effects of specific work carried out under specified conditions and to allow attention to personal needs.

**Simulation:** Simulation is defined as experimental techniques usually performed on a computer, to analyze the behavior of any real-world operating system.

**Standard time:** Standard time is the time required for a qualified and well-trained person, working at a normal pace, to do a specific task.

**System:** A system encompasses a collection of elements (PLC, PC, Pneumatic cylinders, hydraulic cylinders, solenoid valves, , conveyor and the like) between which there is a mutual interaction (interconnection), which can be separated

from these environment of that system (system boundaries). The mutual interaction between the elements of a system realizes the system function, which can, in general, be divided into a number of specified attributes and properties.

**Throughput:** The number of jobs produced per unit of time.

**Time study:** Time study is a tool to work measurement that is used to determine the time required to sort graded plywood.

**Utilization:** Utilization is the degree to which equipment is currently being used.

**Work measurement:** Work measurement was defined, as a set of procedures for determining the amount of time required, under certain standard conditions of measurement, for tasks involving some human activity. The result of such a measurement is called a standard time.

**Work study:** Work study is a generic term for those techniques particularly method study and work measurement, which are used in all its contexts, and which lead systematically to the investigation of all the factors, which affect the efficiency and economy of the situation being received.

# **CHAPTER I**

## **INTRODUCTION**

### **1.1 Introduction**

Competitive pressure and globalization have provided the impetus for innovation and management of new technology. The aspiration to develop Malaysia into an industrialized nation by the year 2020 has initiated the Government to emphasize on the modernization of Malaysian manufacturing industries by enhancement of technological capabilities via adoption of sophisticated technologies (Jantan et al., 2000). Today, the rapidly changing demands have rendered traditional assembly line manufacturing less effective. For the past few decades, researchers have devoted time and effort applying automation and modern computer technologies towards improving the productivity of traditional industries (Klinkhachorn et al., 1995).

Manufacturers have to change the basics layout or system of their plant to accommodate automation system, and one of these changes involve the implementation of the manufacturing cells. Implementing automation system also involves the substitution of machines and can be a complex decision for organizations. There are lots of criteria that should be considered in the implementation of automation system; some of these include total cost, time, labor requirements, work-in-process, space requirements, volume flexibility, and process/routing flexibility (Marcus Syn, 2003).

Demands for wood products are at all time high. Training tools and automated systems are needed to make major processing improvements and proper product allocation. Lack of automation in the primary processing area causes waste and low product yields, and increases demand for additional timber harvesting. Automation systems combined with computerized grading of plywood would help the accuracy of grading, reduce the number of times boards need to be graded and restacked and provide a means to increase the grade of some low-grade plywood (Araman, 1996).

In plywood industry high productivity demands have led to a growing interest of automatic systems. Increasing the capacity of production lines and in the same time preserving or increasing the quality level of the product requires highly automated and reliable measuring systems. Currently, the plywood grading system, are done manually (Lampinen et al., 1995). To be competitive, one must streamline operations and minimize production costs, while maintaining an acceptable margin of profit. Klinkhachorn et al. (1995) in his study of automated lumber processing system; grading the hardwood lumber using automation describes the effort of improving lumber industry in the U.S.A, specifically to automatically grade and analyze hardwood lumber.

Gerber Scientific's engineering expertise has propelled the company's deep technical capabilities in computerized grading system noted that the manual method requires highly skilled craftsmen and is very labor-intensive, while the automated method requires very expensive and complex equipment few shops can afford. Both processes are inconsistent in terms of the quality they provide.

High competition in the sawmill industry requires increasing the speed of the production lines and at the same time to preserve or increase the quality of the final products. Thus the potential in automated grading is very high provided that the grading accuracy is sufficient with respect to the current standards (Holliday, 1999).

These studies (Marcus Syn, 2003; Araman, 1996; Klinkhachorn et al., 1995; and Holliday, 1999) show that problems faced by timber concessionaires in other parts of the world are similar. This is merely to establish the fact that of this study is not confined to a local problem but it is a universal problem.

Acceptance of new technology and innovation as strategic weapons for competitive advantage in the plywood grading line is referred to as new and better way of doing things. Hence the main focus of this study is on the sorting method of graded plywood in the grading line, which is hope to produce maximum productivity and quality output within time while keeping the operation and costs to a minimum. The study will take place in one of the world's largest timber concessionaires under the ASPA Group (Amanah Saham Pahang Berhad), which is Mentiga Corporation Berhad in Pekan, Pahang.

## **1.2 Background Problem**

For the year reviewed in 1995, the Malaysian economy continues to achieve strong overall growth. Production in the manufacturing sector increases by 12.2 percent over 1995. The timber and wood based industries however registered

lower production rates. The tropical plywood market has remained relatively stagnant since mid-1995. Supply of plywood is fairly elastic with many mills presently operating below their capacity (Mentiga Corporation Berhad, Annual report, 1996).

The slowdown in the Malaysian economy during the second half of 1997 has affected the performance of Mentiga Corporation Berhad's group. The Group recorded a turnover of RM114 million in 1997 against RM127 million in 1996, a decline of 10.2 percent. The decrease in turnover was mainly due to depreciation in world market prices of plywood. Plywood product substitute such as OSB, MDF, fibre cement and other complimentary products are gaining larger market share (Mentiga Corporation Berhad Annual report, 1997).

In view of the unfavorable developments and difficult conditions, the Group recorded a lower turnover of RM66 million in 1998 against RM114 million in 1997, a decline of 42%. Accordingly the group suffered a loss of RM 18 million after taxation in 1998 compared to profit of RM1 million in 1997. The decrease in turnover was mainly due to stagnant market for wood namely plywood (Mentiga Corporation Berhad Annual report, 1998).

Indeed, the year 2000 has been another difficult year for the Group and the Company. The economy downturn of 1997, which had not recovered fully during the financial year, continued to affect the performance of the Group. The decrease in operating revenue achieved by the Group was mainly due to lower contributions from the manufacturing division in sale volume and lower selling prices. This is caused by the availability of cheaper plywood produced from other



tropical countries like Indonesia and Brazil (Mentiga Corporation Berhad Annual report, 2000).

According to the company daily, and monthly production report from March to May 2002, the graded plywood production rate is below the target of the company. The output rate per day is 261 pieces while the target is 328 pieces per day. It is 20.5% below the target. In addition, it was found that the company has very high labor usage for sorting graded plywood. The average cost of these laborers per day is RM265.59 and per hour is RM33.21. It was found that the average percentage of the defective rate per week is 0.88% and per month is 0.014%

Modification to the sorting system in the grading line should be done. Using automation system as an alternative could increase the graded plywood production rate, lower the labor usage and reduce graded plywood defective rate. Hence the productivity will be increased and the price of this plywood product could be reduced in order to compete with other plywood product substitutes and cheaper plywood produced from tropical country.

### **1.3 Problem Statement**

The plywood grading line is the final process in the production line. Through the existing plywood grading line, the plywood is sorted into four grades. The finished plywood is firstly placed on a hydraulic platform by a forklift. There is one operator grading the plywood manually with a chalk and two other operators